MANAGEMENT OF GARTLAND TYPE III SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN BY OPEN REDUCTION AND INTERNAL FIXATION USING CROSSED K – WIRES.

- A SHORT TERM FOLLOW UP STUDY

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CERTIFICATE

This is to certify that **DR.G.A.RAJMOHAN,** postgraduate (2006-2008) in the Department of Orthopaedics and Traumatology, Thanjavur Medical College and Hospital, Thanjavur, has done this dissertation on **"MANAGEMENT OF GARTLAND TYPE III SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN BY OPEN REDUCTION AND INTERNAL FIXATION USING CROSSED K – WIRES - A SHORT TERM FOLLOW UP STUDY"** under my guidance and supervision in partial fulfilment of the regulation laid down by the TamilNadu DR.M.G.R. Medical University, Chennai for MS (Orthopaedics) degree examination to be held on March 2008.

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"I dedicate this work to my parents"

CONTENTS

INTRODUCTION

Sir Robert Jones said “The difficulty experienced by an orthopaedic surgeon is mainly an accurate diagnosis, the facilities with which serious blunders can be made in prognosis and treatment, and the fear shared by so many, of the injuries, of the neighbourhood of elbow less attractive than they might have otherwise proved.”

Nowhere else this is more illustrated than in supracondylar fracture of humerus which is one of the commonest elbow injuries in paediatric age group. The functional results following supracondylar fracture of humerus with conservative treatment are satisfactory but the cosmetic results are poor. These are relevant even in modern era.

The presentation of a child with a swollen elbow still brings some feeling of anxiety to the treating orthopaedic surgeon.

Between the mid 20th century, an early report of pinning distal humerus fractures first appeared, after that the treatment of supracondylar fractures has evolved tremendously.

Blount's[1] caution against operative management has given way to modern concepts of treatment involving skeletal stabilisation and soft tissue management which have greatly improved outcomes.

Problems of neurovascular compromise Volkmann's ischemic contracture and deformity have been greatly decreased but not eliminated.

The complications can be minimised by achieving good anatomical reduction. There are various modalities of treatment available like closed reduction and Plaster of Paris immobilization, various types of traction, closed reduction and percutaneous pinning and open reduction and internal fixation.

Closed reduction and application of casts with the elbow in flexion is one of the oldest and most widely used methods of treatment. There are concerns about the dangers and difficulties of this method especially the risk of Volkmann's ischemic contracture and high incidence of cubitus varus.

These complications can be prevented by achieving anatomical reduction by open reduction and internal fixation with crossed K-wires. This is relatively a simple procedure with maximum benefit to the young patients.

AIM

The aim of this study is to evaluate the outcome of management of Gartland type III supracondylar fracture of humerus in children by open reduction and internal fixation using crossed K – wires.

HISTORICAL REVIEW

AND LITERATURE

Supracondylar fractures were described in the early writings of Hippocrates during the 3rd and 4th century A.D. But it was not until 1700s that much was written about supracondylar fractures in the classic medical literature.

Dupuytren mentioned the findings of crepitus with the fracture. **Malgaigne** demonstrated that there was preservation of the Olecranon –Humeral condylar relationship with the fracture but not with the dislocation.

Most of the discussions during 1700s and 1800s were directed towards the controversy regarding the correct position of immobilisation.

Desault from Paris in 1800 said that poor results were due to poor management and not inevitable with this type of fracture. He demonstrated better results with this prompt recognition and careful management of the fractures.

Jones and Thomas propounded treatment in flexed position, which we follow while **Listen and Allis** were in favour of extended position.

At the beginning of 20th century, treatment began to change from these simple passive methods to more aggressive and active methods. Scientific reason and study began to alter the methods of treatment and open reduction and internal fixation came into vogue.

Herzenberg and co-workers conducted in-vitro studies of pin stability and found the 5/64" Steinmann pins placed from medial to lateral entrance points proved the best stability.

Ziont's and co-workers[2] demonstrated the resistance of various patterns to rotational stresses.

Cheng J.C, LamT.P, Shen W.Y and co-workers concluded that cross pinning was found to be effective

in treatment of Gartland type III extension fractures with a high success rate and minimal complications.

Mohammed.S and Rymaszewski.L.A[35] in a study conducted at the Glasgow Royal Infirmary between June1990 and September 1992, on 32 displaced supracondylar fractures of humerus in children concluded that open reduction and internal fixation with two K–wires gave the best results.

Aronson D.C, Van Vallendhoven E, Meeuwis J.D in a study conducted on 11 children with supracondylar fractures of humerus treated with open reduction and K wire fixation by a ventral approach concluded that K wire fixation of supracondylar fractures in children gives excellent results.

Furrer.M, Mark.G and Ruedi.T[3] did a open reduction and crossed K-wire fixation on 33 children with displaced supracondylar fractures of the humerus and recommended that it is the ideal method of treatment.

ANATOMY

Elbow is a complex joint composed of three individual joints. Articulation occurs between the trochlea and capitulum of the humerus with the trochlear notch of the ulna and the head of the radius. In proximal radioulnar joint articulation occurs between the circumference of head of radius, the annular ligament and the radial notch. The articular surfaces are covered with hyaline cartilage.

DISTAL END OF HUMERUS:

The distal end of humerus is divided into medial and lateral columns. Each of the columns are roughly triangular and is bound on its anterior border by supracondylar ridge.

From the structural and functional stand points the distal humerus is divided into separate medial and lateral

components each containing an articulating and non articulating portion. Included in the non-articulating portion are the epicondyles which are the terminal portion of the supracondylar ridge. The lateral epicondyle contains a roughened anterolateral surface from which the superficial forearm extensor muscles arise. The medial epicondyle is larger than the lateral counter part and serves as the origin of the forearm flexor muscles.

The posterior distal portion of the medial epicondyle is smooth and in contact with the ulnar nerve as it crosses the elbow joint.

When a condyle losses continuity from its supporting column, as in a fracture displacement the nerve can get injured by direct compression by the fracture fragments. This should be well born in mind while treating supracondylar fractures.

The articulating surface of the medial epicondyle, the trochlea, is more cylindrical or spool like.

It has a very prominent medial and lateral ridges. Between these ridges is a central groove that articulate with the greater sigmoid notch of proximal ulna. The groove originates anteriorly in the coronoid fossa and terminates in the posterior surface of the trochlea. The groove is directed slightly laterally.

This obliquity of the trochlear groove produces the valgus carrying angle of the forearm when the elbow is extended.

Proximal to the condyles on the anterior surface of the humerus lie the coronoid and radial fossa. They articulate with the coronoid of ulna and the radial head, respectively when the elbow is flexed. Posteriorly the olecranon fossa is a deep hollow for the reception of olecranon process, making it possible for the elbow to go into full extension. The bone

that separates this anterior and posterior fossa is extremely thin and translucent[4].

UPPER END OF RADIUS:

The proximal end of radius consists of the disc shaped head, the neck and the radial tuberosity.

The head and part of the neck lie within the joint. The shallow concavity of the head articulates with the capitulum.

UPPER END OF ULNA:

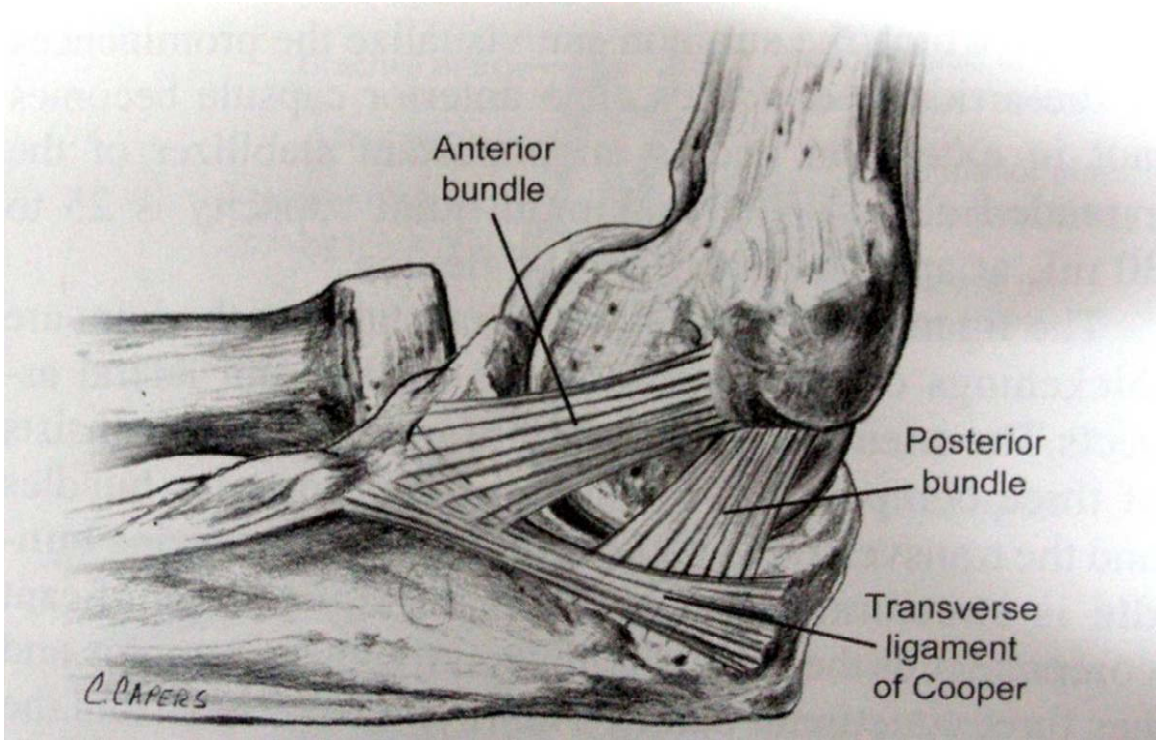
The proximal end consists of the olecranon and coronoid process, which together form the semilunar notch. The triceps inserts by a broad tendinous insertion into the olecranon posteriorly. On the anterior surface the brachialis muscles inserts into the coronoid process.

The triceps play an important role in maintaining the reduction of supracondylar fracture and its integrity is important for that and to avoid extensor lag.

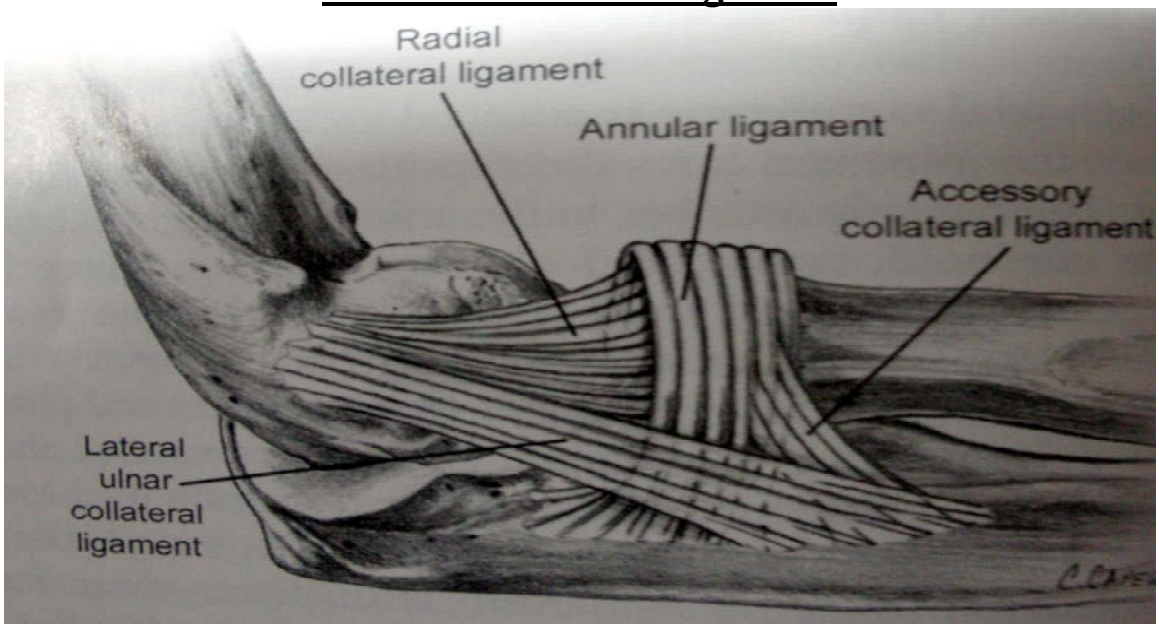
COLLATERAL LIGAMENTS:

The collateral ligaments supplement the natural stability of the elbow joint. The triangular radial collateral ligament is attached by its apex to lateral epicondyle of humerus and by its base to the upper margin of annular ligament. The thicker and stronger ulnar collateral ligament consists of three bands. The anterior band passes from medial epicondyle of humerus to medial margin of coronoid process. The posterior band passes from medial epicondyle of humerus to medial side of olecranon. The transverse band passes between the ulnar attachments of the two preceding bands.

Medial Collateral Ligament



Lateral Collateral Ligament



CAPSULE:

Anteriorly it is attached above to the humerus along the upper margins of the coronoid and radial fossae and to the front of medial and lateral epicondyles and below to the margin of coronoid process of the ulna and to the annular ligament

Posteriorly it is attached above to the margins of olecranon fossa of humerus and below to the upper margin and sides of the olecranon process of ulna and to the annular ligament.

NEUROVASCULAR ANATOMY OF THE ELBOW :

The orthopaedic surgeon should be well versed with the neurovascular arrangement in the elbow to operate on the young patients.

The brachial artery is the most important artery in the anterior aspect of the distal end of the humerus[5]. This is the most common vascular structure to be involved in extension type of supracondylar fracture.

The median nerve lies medial to the brachial artery which can also be injured. The radial nerve may be injured, if the spike is displaced laterally[5,6].

The ulnar nerve passes posteriorly to the medial epicondyle in the ulnar tunnel and emerge in the anterior aspect winding around the medial epicondyle, this may be injured in flexion type of supracondylar fracture[5,6].

MOVEMENTS:

Elbow joint is capable of flexion and extension. Proximal radioulnar joint involves in pronation and supination. Flexion is performed by the brachialis , biceps brachii, brachioradialis and pronator teres muscle. Extension is performed by the triceps and anconeus muscles.

IMPORTANT RELATIONS

Anteriorly : The brachialis, the tendon of biceps, the median nerve and brachial artery.

Posteriorly : Triceps, a small bursa intervening.

Medially : Ulnar nerve passes behind the medial epicondyle and crosses the medial ligament of the joint .

Laterally : The common extensor tendon and the supinator

OSSIFICATION PROCESS:

Sequence and timing of ossification in the elbow[7]		
	Girls (y)	Boys(y)
Capitellum	1.0	1.0
Radial head	5.0	6.0
Medial epicondyle	5.0	7.5
Olecranon	8.7	10.5
Trochlea	9.0	10.7
Lateral epicondyle	10.0	12.0

In the above mentioned data it is quoted that the olecranon ossifies earlier than the trochlea.

SUPRACONDYLAR AREA OF HUMERUS IN CHILDREN:

There is a considerable difference in the bony architecture of the supracondylar area of child and adult.

At the age of peak incidence of supracondylar fractures, the bone in the supracondylar area is undergoing remodelling with a decrease in both anteroposterior and lateral

dimensions. It is less cylindrical than in adult. The metaphysis of the child extends just distal to two fossae. Because this is a newly formed bone, the trabeculae are less defined and thinner and the cortex is very slender.

In the lateral projections the anterior cortices of the medial and lateral epicondylar column do not project as far anteriorly thus producing an anterior defect in the area of coronoid fossa.

LIGAMENTOUS LAXITY :

Ligamentous laxity with hyperextension of joints is normal in younger children. Thus as the younger child falls with the arm outstretched, the elbow is more likely to be hyperextended at the time of the fall.

Thus the local bony and ligamentous anatomy is a major factor in producing supracondylar fracture during the first decade of life[8].

BIOMECHANICS AND MECHANISM OF INJURY :

The bone in the supracondylar area is weaker during the last part of first decade of life because it is undergoing metaphyseal remodelling. The thinnest portion occurs at the depth of the olecranon fossa posteriorly and the coronoid fossa anteriorly[4]. It is because of this distinct distal humeral anatomy that a supracondylar fracture is so unstable.

Supracondylar fractures generally occur as a result of fall onto the outstretched hand with elbow in full extension. The olecranon in its fossa in the distal humerus acts as a fulcrum, whereas the capsule transmits an extension force to the distal humerus just proximal to the physis as the elbow hyperextends.

In addition, the large amount of elastic epiphyseal and articular cartilage in the distal portion can serve as a buffer to transfer the force of hyperextension injury to supracondylar area.

Posterior displacement of the distal fragment occurs with proximal fragment impaling the anterior soft tissue structures. The fracture in the sagittal plane extends obliquely from anterior and distal to posterior and proximal.

As the distal fragment displaced posteriorly the anterior periosteum fails and tears away from it. Intact medial or lateral periosteal hinge provides stability after reduction[11,12].

Posteromedial displacement of the distal fragment is more common than posterolateral displacement. The biceps tendon insertion and axis of muscle pull lies medial to the shaft of humerus, this anatomic location of muscle pull created a force that tend to displace the distal fragment medially.

CLASSIFICATION:

Classification of fracture type is useful only if it enables the physician to make a decision about treatment or provide some type of prognosis.

Since extension type of supracondylar fracture is the commonest type, numerous attempts have been made to classify this type of fracture. These initial type of classifications have been based on two factors :

1. The type and location of fracture line.
2. The degree of displacement.

Classification of extension supracondylar fractures by Gartland[9]:

Type I Undisplaced.

Type II Displaced (with intact posterior cortex)

Type III Displaced (no cortical contact)

A. Posteromedial

B. Posterolateral.

Type I fractures have no displacement. It often manifests only by a posterior fat pad sign[10].

Type II fractures have a green stick fracture pattern. The distal fragment displaced posteriorly with intact posterior cortex. The presence of intact posterior cortex provides sufficient internal stability.

Type III fractures have complete destruction of posterior cortex, and the distal fragment is displaced posteriorly. The triceps tends to displace the distal fragment proximally. The distal fragment may be either posteromedial or posterolateral in relation to the proximal fragment

DIAGNOSIS

The diagnosis is relatively simple. Sometimes there is difficulty in classifying the fracture. Apart from the classical signs and symptoms of fractures namely

- Pain
- Tenderness
- Abnormal mobility
- Inability to use the limb

The diagnosis was based on the following criteria

1. Deformity.
2. Pucker sign.
3. Differentiation from dislocation of elbow.
4. Anconeous soft spot.
5. X-ray diagnosis

    - Standard AP view
    - Lateral view
    - Jones view

Deformity

Pucker Sign and Echymosis

Radiological diagnosis was difficult in type I and minimally displaced type II fractures

The standard indicators were

1. AP view
    - Baumann's angle[4]
    - Humeral - Ulnar angle
    - Metaphyseal-Diaphyseal angle
2. Lateral view
    - Shaft condylar angle
    - Anterior humeral line
    - Fat pad signs of elbow[10]

CONTEMPORARY MANAGEMENT

A neurological evaluation and vascular assessment should be done initially.

Type I fractures:

These are managed by simple immobilization. The limb is placed in a posterior splint applied at 60 to 90 degrees of elbow flexion with side supports. X-rays are obtained after seven days of fracture to document lack of displacement and a long arm cast can then be applied. The duration of immobilization is 3-4 weeks.

Type II fractures:

In this incomplete osseous separation with intact posterior cortex, good stability can be obtained with closed reduction. Significant swelling, obliteration of pulse with flexion, neurovascular injuries, excessive angulation, medial

column collapse are indicators for pin stabilization. If pin stabilization is used, pins are removed at 3-4 weeks.

Type III fractures:

These are completely displaced fractures.

Management of type III can be broadly classified into:

1. Closed reduction and cast immobilization.
2. Traction.
3. Closed reduction and percutaneous pinning.
4. Open reduction and internal fixation.

Closed reduction and cast immobilization[11,12]:

The patient is anaesthetised, under image control the affected arm is extended. Longitudinal traction is applied first to dislodge the proximal fragment. Once the length is restored medial or lateral translation is corrected next. Rotation is corrected simultaneously, but in general malrotation resolves as traction is applied and as the medial

and lateral alignment is corrected, due to the effect of surrounding soft tissue. A flexion reduction manoeuvre is performed with pressure of the thumb over the condyles of the humerus. The reduction can be felt. The elbow is flexed to 120 degrees and forearm is pronated[13] if the initial displacement is medial. Figure of eight cast is used to maintain reduction. It should be worn for 3-4 weeks. After cast removal the limb is placed in a sling until the patient is comfortable.

Traction[14]:

Both skin and skeletal traction has been used for many years to achieve and maintain reduction. In Dunlop's side arm traction the forearm is held in supination which tends to force the distal fragment into varus. In olecranon pin traction either smooth K wire or a vertical skeletal screw is used. Although traction is an effective method of treating severely swollen or displaced fractures, immediate open reduction

provides many more advantages and is becoming a more acceptable alternative.

Closed reduction and Percutaneous pinning:

After closed reduction the reduction is maintained by percutaneous pinning. This can be done either as a crossed pinning or passing 2 parallel K wires parallel to each other from the lateral epicondyle. In posteromedial fracture pattern the medial pin should be placed first. Likewise the lateral pin should be placed first for posterolateral fracture.

For a successful outcome near anatomic reduction and adequate pin placement are needed. Use of power drills and image intensifier are mandatory. Closed reduction of the fracture and maintaining it during pinning needs experience[15].

Pinning by Open reduction with crossed K wires:

Open reduction is indicated in displaced supracondylar fractures where irreducibility results from proximal fragment being buttonholed[16] through soft tissue or interposition of biceps or neurovascular structures. Approaches for open reduction are anterior, posterior, medial and lateral. Posterior approach through triceps muscle and tendon has been used with excellent results. Posterior approach[23,24,25] is easier when comparing with other approaches. K wires 1.5mm to 2mm are used in crossed pin technique. After reducing the fracture visually lateral pin is inserted first and second pin is placed medially. Both the pins should have a purchase on the opposite cortex. Elbow is immobilised in flexion with forearm in neutral position using above elbow posterior slab.

Open reduction and internal fixation with two K wires[17,18,19,20,21,22] is the optimal method of treatment. This

does not need a C- arm which is ideal in our setup in emergency trauma care.

COMPLICATIONS

Neurologic Injury[5,6] :

Neural injuries occur in 5% to 19% of the displaced fractures. Anterior interosseous nerve is injured most often. The radial nerve, median nerve and ulnar nerve are also injured in that order. Posterolateral displacement of the distal fragment is highly associated with median nerve injury. Posteromedial displacement of the distal fragment is associated with radial nerve injury. Ulnar nerve is injured most often in flexion type of fracture than in extension type. Ulnar nerve may also injured in percutaneous medial pinning. Examination for nerve palsy prior to reduction is important because entrapment of nerve especially median nerve can occur during reduction. Most of the palsies resolve spontaneously, routine exploration is not recommended. Exploration is recommended for palsies that do not recover spontaneously by 6 months

Vascular Injury[5,6]:

Vascular insufficiency is reported in 3% to 12% of displaced supracondylar fractures. Fortunately, less than 1% have a significant risk of sequelae from vascular compromise. Presence of pulse and perfusion of hand should be documented. Initial approach to the pulseless limb is to immobilise in less than 90 degree of flexion and should be monitored. Perfusion is estimated by colour, warmth and capillary refill. Exploration of the brachial artery is advocated only when there is absent pulse with signs of ischemia after reduction. Diligent observation and appropriate treatment will reduce the risk of Volkmann's ischemia.

Cubitus Varus[26,27]:

It is the most common complication of supracondylar fracture of the humerus. Cubitus varus occurs after poor reduction or loss of reduction. Malunion of the fracture occurs in three planes: internal rotation in the horizontal plane, medial rotation in the coronal plane, and extension in the sagittal plane. It is more of a cosmetic deformity than functional. But patients having cubitus varus deformity find difficult in throwing sports, push-ups and swimming. In patients who do not tolerate the deformity corrective osteotomy should be considered,

MATERIALS AND METHODS

In our institution we selected 33 cases of Gartland type III paediatric supracondylar fractures for this prospective study. The age group varied from a minimum of 3 years to a maximum of 13 years. The duration of study was from June 2006 to October 2007

Of the 33 children 26 were males and 7 were females. Of the side right was involved in 8 cases and left was involved in 25 cases.

SELECTION CRITERIA:

1. Age of the child between 3 years and 13 years
2. Extension- Gartland type III supracondylar fractures
3. Closed fractures

EXCLUSION CRITERIA :

1. Gartland type I and II fractures
2. Fractures with impending compartment syndrome
3. Open fractures
4. Fractures with neurovascular compromise
5. Cases taken up for surgery later than 24 hours post injury (unfit for anaesthesia post injury due to lower respiratory tract infection, anaemia etc.)

On admission in our emergency service, detailed clinical examination of the case was carried out. After ruling out neurovascular compromise above elbow posterior slab was applied to immobilize without compromising vascularity and limb was elevated to reduce oedema.

All cases were given preoperative antibiotic (inj.Cefotaxime – 50 mg/kg)

All cases were taken up for surgery within 24 hours post injury

SURGICAL TECHNIQUE

Under general anaesthesia the patient in lateral position the affected limb was hanged over the sand bag with elbow in flexion. Tourniquet was applied after elevating the limb for 5 minutes. The Campbell's posterior approach was used. First step was to identify the ulnar nerve and safeguard it. After raising triceps aponeurosis tongue flap and splitting of triceps, the fracture ends were identified and reduced under vision. Lateral K- wire was introduced from lateral epicondyle, crossing the physis and always engage medial cortex proximally. Medial pin was inserted through medial epicondyle with a precaution not to damage the ulnar nerve and engage the opposite cortex. Wires were bent and cut. They were kept inside the wound to prevent accidental removal of pins post operatively. Wound was closed in layers keeping suction drain insitu. Tourniquet was released, posterior above elbow slab was applied with elbow in flexion. Check X ray was taken and reduction was judged by Baumann's angle. Patient was discharged after one week,

with weekly review for upto 5th week. Then the patient was reviewed monthly once. Posterior slab was discarded at the end of 3rd week. Active elbow mobilisation exercises was advised. K- wire removal was done after confirmation of solid union of fracture by observing callus formation. Usually K – wires were removed as a out patient procedure at the end of 3rd , 4th or 5th week depending upon union. Patients were advised against massaging and passive mobilisation. At the follow up elbow range of movements and carrying angle were noted according to Flynn's criteria.

Flynn's Criteria[28]

Results	Cosmetic factor- loss of carrying angle(degree)	Functional factor-loss of motion (degree)
Excellent	0-5	0-5
Good	6-10	6-10
Fair	11-15	11-15
Poor	>15	>15

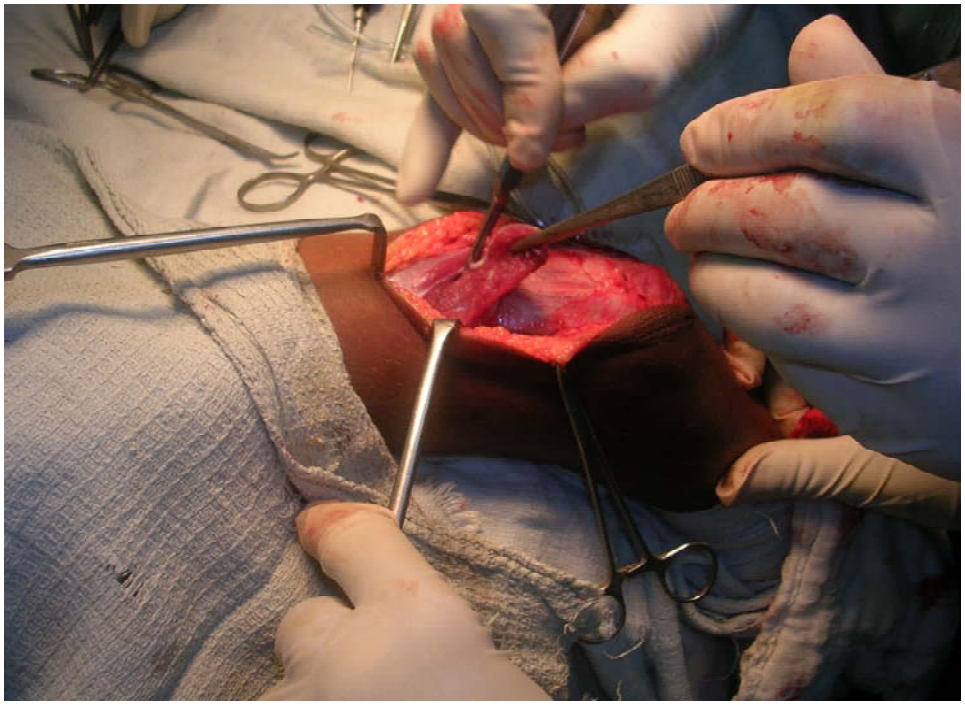
Surgical Technique

Position of the patient

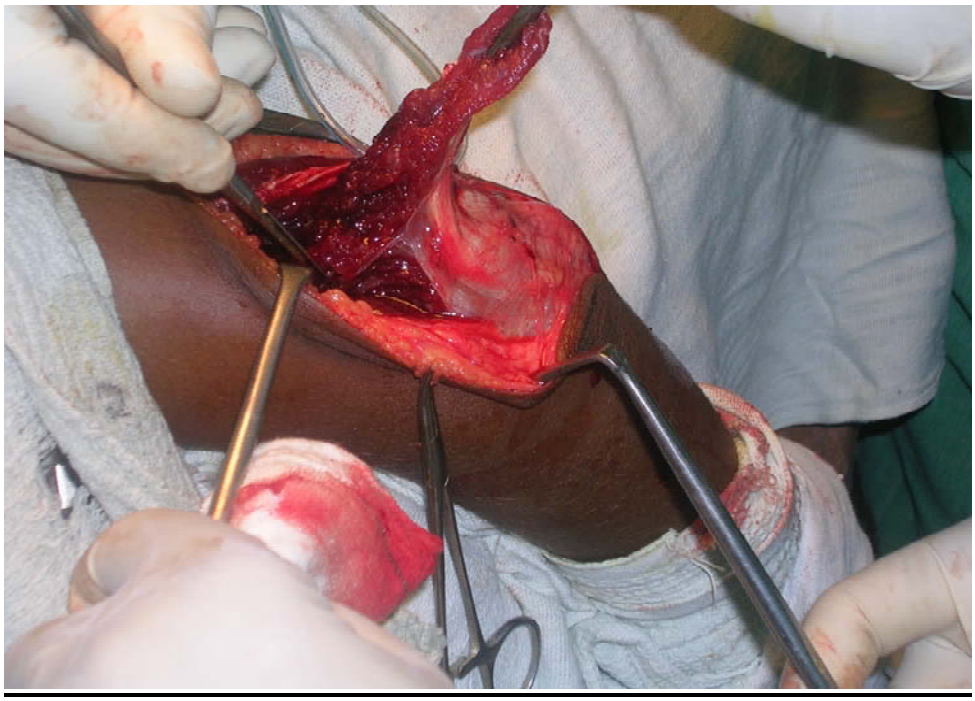
Skin Incision

Ulnar Nerve Safeguarding

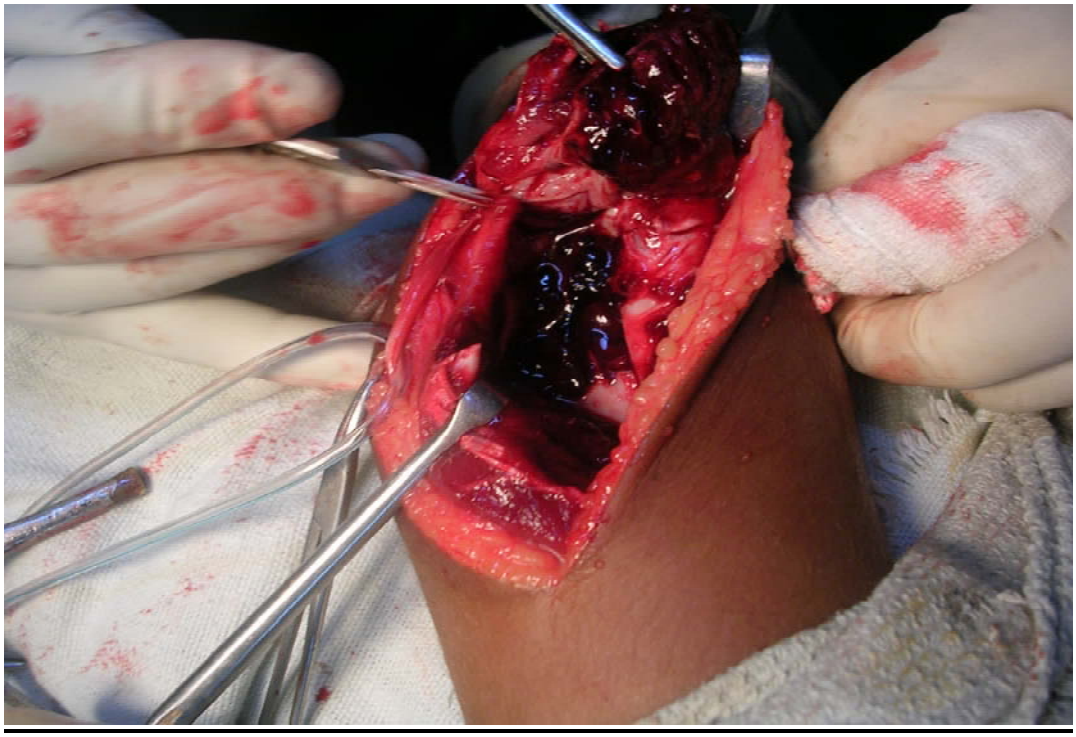
Triceps Tongue Flap



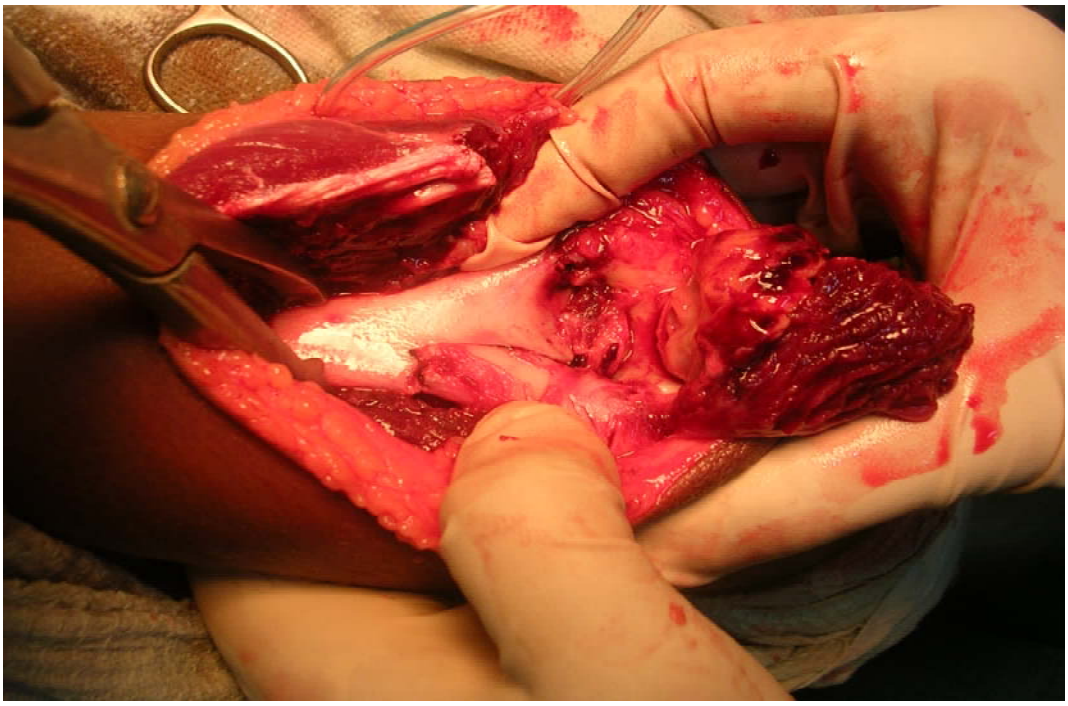
Triceps Muscle Splitting



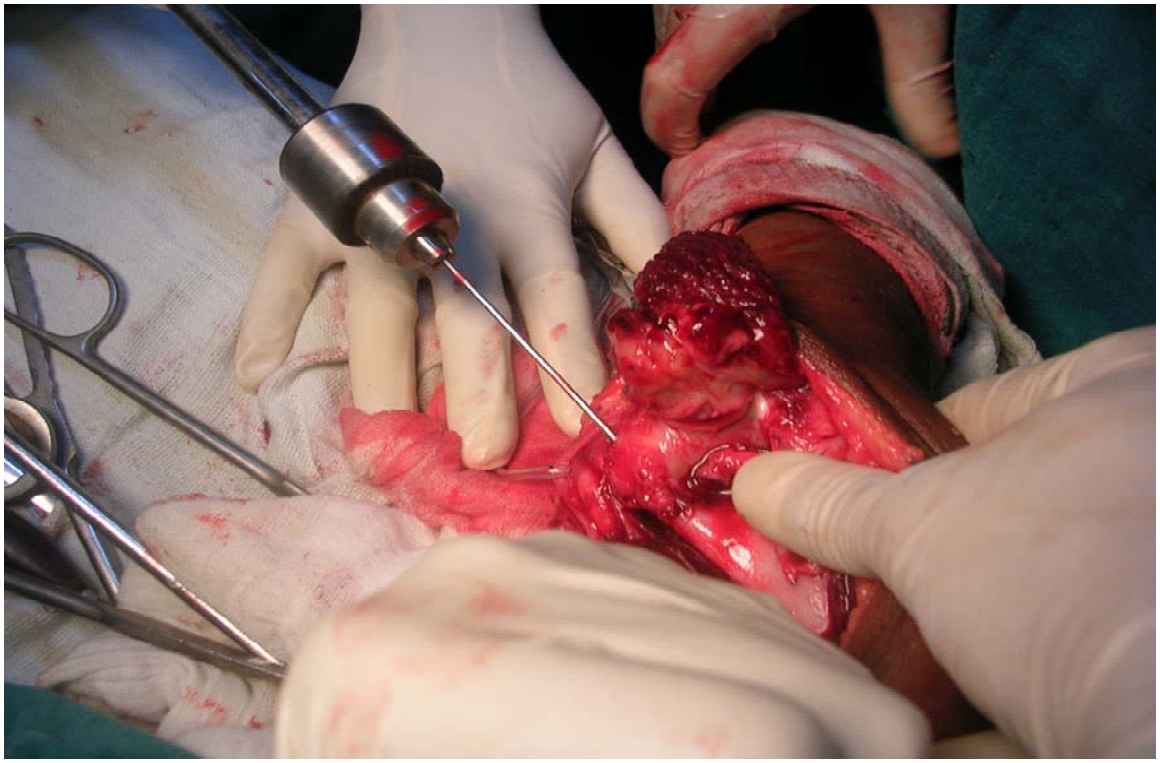
Haematoma Evacuation

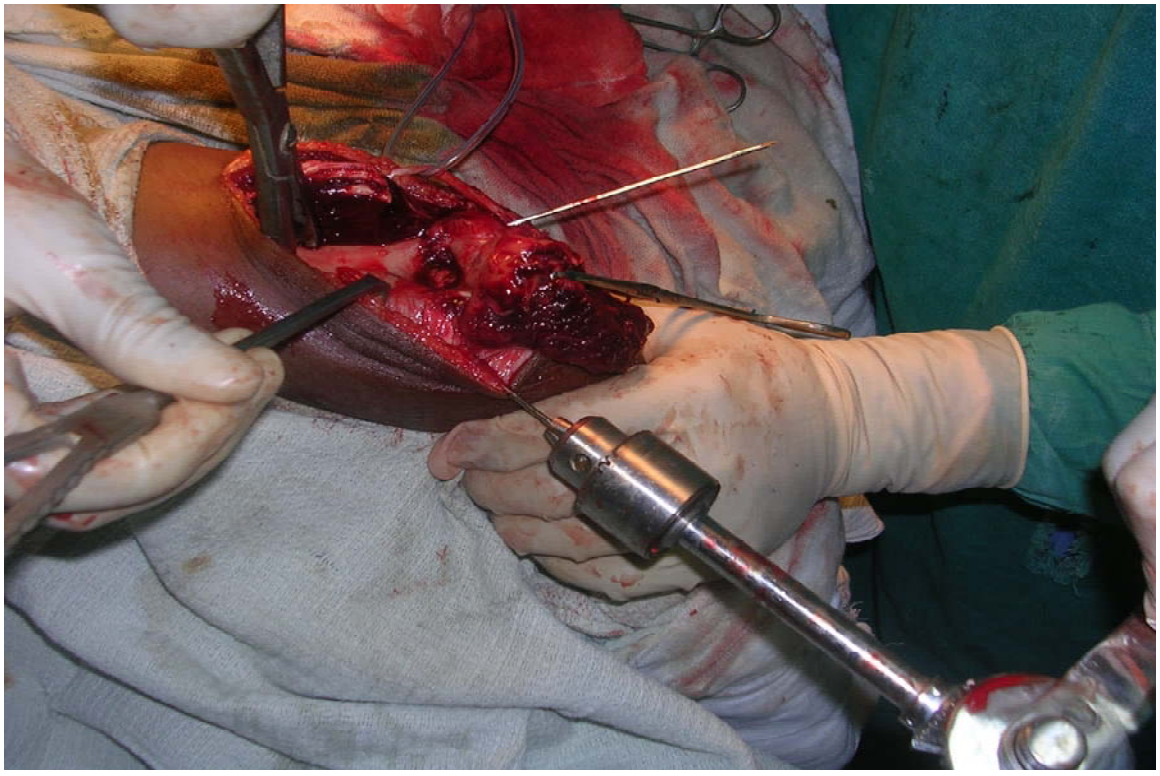


Reduction

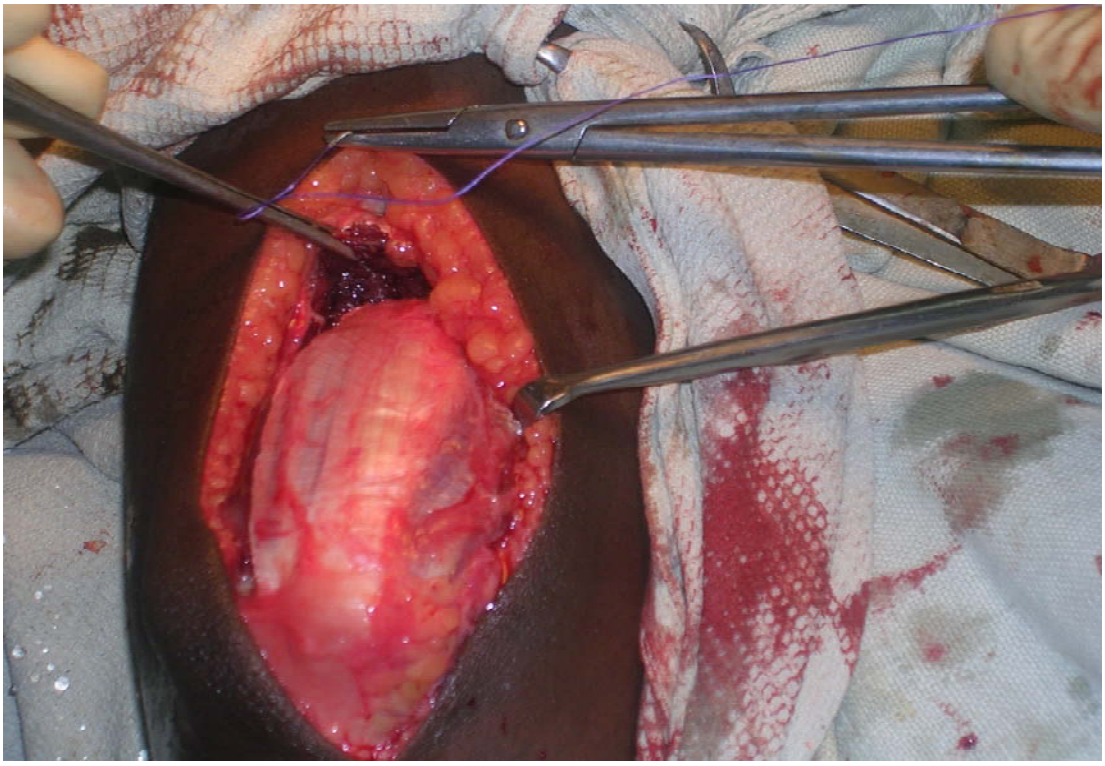


Crossed K- Wire Fixation





Triceps Resuturing



Post operative X- Ray

OBSERVATIONS AND RESULTS

Out of thirty three children who presented with extension Gartland type III supracondylar fracture , twenty six (78.8%) were males and seven (21.2%) were females. Elbow on the left side was involved in twenty five (75.6%) patients and the right side was involved in eight (24.4%) patients. Age range was from three to thirteen years with maximum patients received between six to nine years. Thirty one patients (93.9%) were taken up for surgery within twelve hours of injury and remaining two (6%) patients within twenty four hours. Twenty eight (84.8%) patients were having no complications in post-operative period. Two (6.1%) patients had pin tract infection which were settled after the K – wire removal and appropriate antibiotics. Three patients (9.1%) had superficial wound infection which were settled after administering appropriate antibiotics. K- wires were removed in three weeks for six (18%) patients, four

weeks for twenty three (70%) patients and in five weeks for four (12%) patients.

According to Flynn's criteria thirty (90%) patients were found to have excellent outcome two (6%) patients turned out with good outcome and one (3%) patient turned out with fair outcome. In our study three patients had more than five degrees of range of motion loss compared to the other side. All these patients had superficial wound infections in the post - operative period. For these patients loss of carrying angle could not be measured due to persistant fixed flexion deformity. Neurovascular compromise was not seen in any of our patients.

Table I: Distribution and comparison of age by gender

AGE (Years)	Males (n=26)	Females (n=7)	χ^2 / t value	P value
3-5	5 (62.5)	3(37.5)	3.613	0.163
6-9	14(93.3)	1(6.7)		
10-above	7(70)	3(30)		
Mean ± SD all cases	7.65 ± 2.95	7.43 ± 3.2	0.176	0.861

There are 26 (78.8%) males and 7 (21.2%) female young patients in the study. The over all mean age of the patients is 7.61 ± 2.96 years. The minimum age is 3 years and maximum is 13 years. Eight patients (24.2%) are in less than six years age group, 15(45.6%) are in 6-9 years age group and 10(30.2%) are in greater than 9 years age group. Table I shows there is no statistical significant ($P>0.05$) association between age and gender of the patients who under gone this procedure.

Table II: Distribution and comparison of age based on the side of the fractured limb

AGE (Years)	Left side (n=25)	Right side (n=8)	χ^2 /t value	P value
3-5	5 (62.5)	3(37.5)	1.011	0.603
6-9	12(80)	3(20)		
10-above	8(80)	2(20)		
Mean ± SD all cases	7.80 ± 2.78	7.0 ± 3.59	0.660	0.514

From Table II it can be seen that there are 25(75.6%) patients had left side fractured limb and 8(24.4%) had right side fractured limb. Irrespective of age group left side fracture is more predominant. In 3-5 years age group a maximum of 3 out of 8 patients (37.5%) had right side fracture as compare to other age groups. The distribution of fracture side is comparable across age groups (P>0.05)

Table III : Distribution and comparison of age based on the complication

AGE (Years)	No complication (n=28)	Pin tract Infection (n=2)	Wound Infection (n=3)	χ^2 /F value	P value
3-5	8 (100)	-	-	8.721	0.068
6-9	14(93.3)	1(6.7)	-		
10-above	6(60)	1(10)	3(30)		
Mean ± SD (all cases)	7.07 ± 2.71	9.0 ± 4.24	11.67±1.16	4.212	0.024#

P<0.05:- # No complication Vs Wound Infection

In the study 28(84.8%) patients did not have any complication, 2 (6.1%) patients had pin tract infection and 3 (9.1%) patients had wound infection. None of the subjects developed complication in 3-5 years age group, 1(6.7%) patient developed complication in 6-9 years age group and 4 (40%) patients developed complication in more than 10 years age group. The mean age of patients with out complication is 7.07 ± 2.71 years, Pin tract infection is 9.0 ± 4.24 years and wound infection is 11.67±1.16 years.

Table IV : Distribution and comparison of age by K wire removal time

AGE (Years)	3 week (n=6)	4 weeks (n=23)	5 weeks (n=4)	χ^2 /F value	P value
3-5	6 (75)	2(25)		32.354	0.001
6-9	-	15(100)			
10-above	-	6(60)	4(40)		
Mean ± SD (all cases)	3.67 ± 0.82	7.83 ± 2.06	12.25 ± 0.96	27.24	0.001 † ϕ ¶

P<0.05: †: 3weeks Vs 4 weeks, ϕ: 3 weeks Vs 5 weeks, ¶: 4 weeks Vs 5 weeks

For all the patients the K wires were removed 3 weeks, 4 weeks or 5 weeks. For 23 (70%) patients the K wires were removed in 4 weeks time. For 6 (18%)) patients it was done in 3 weeks. For 4 (12%) patients it was done in 5 weeks. Six out of 8 patients in 3-5 years age group had 3 weeks removal of K wire where as none of the 6-9 and more than 9 age group had 3 week removal. The mean age of the subjects who had K wire removal in 3 weeks is 3.67 ± 0.82, in 4 weeks is 7.83 ± 2.06 and in 5 weeks is 12.25 ± 0.96 years. The mean age is significantly (P<0.05) lower in those subjects to whom the K wire was removed in 3 weeks as compared to 4 weeks, which was significantly (P<0.05) lower than 5 weeks.

Table V : Distribution and comparison of age based on FLYNN criteria

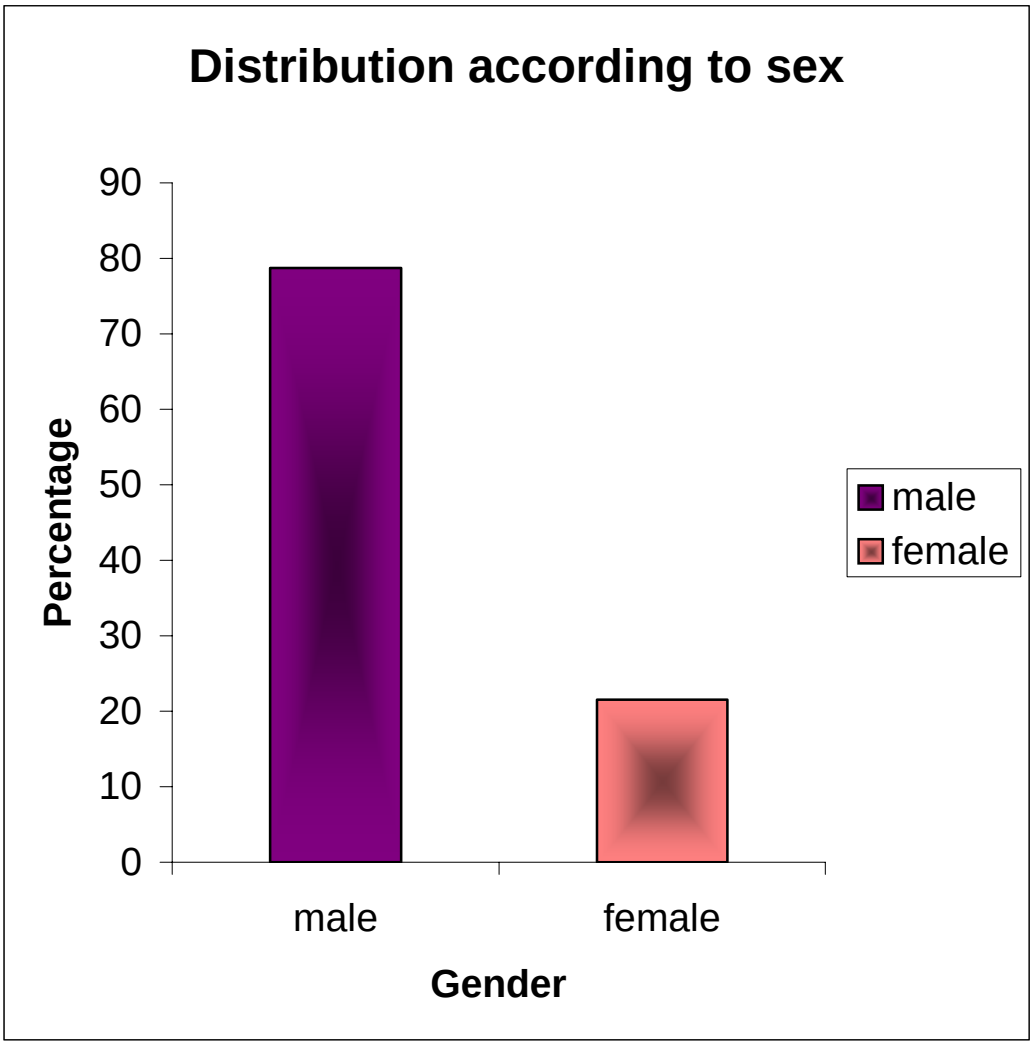
AGE (Years)	Excellent (n=30)	Good (n=2)	Fair (n=1)	χ^2 /t value	P value
3-5	8 (100)	-	-	8.721	0.068
6-9	15(100)	-	-		
10-above	7(70)	2(20)	1(10)		
Mean ± SD all cases	7.2 ± 2.77	12.0±1.42	11.0	2.74§	0.010

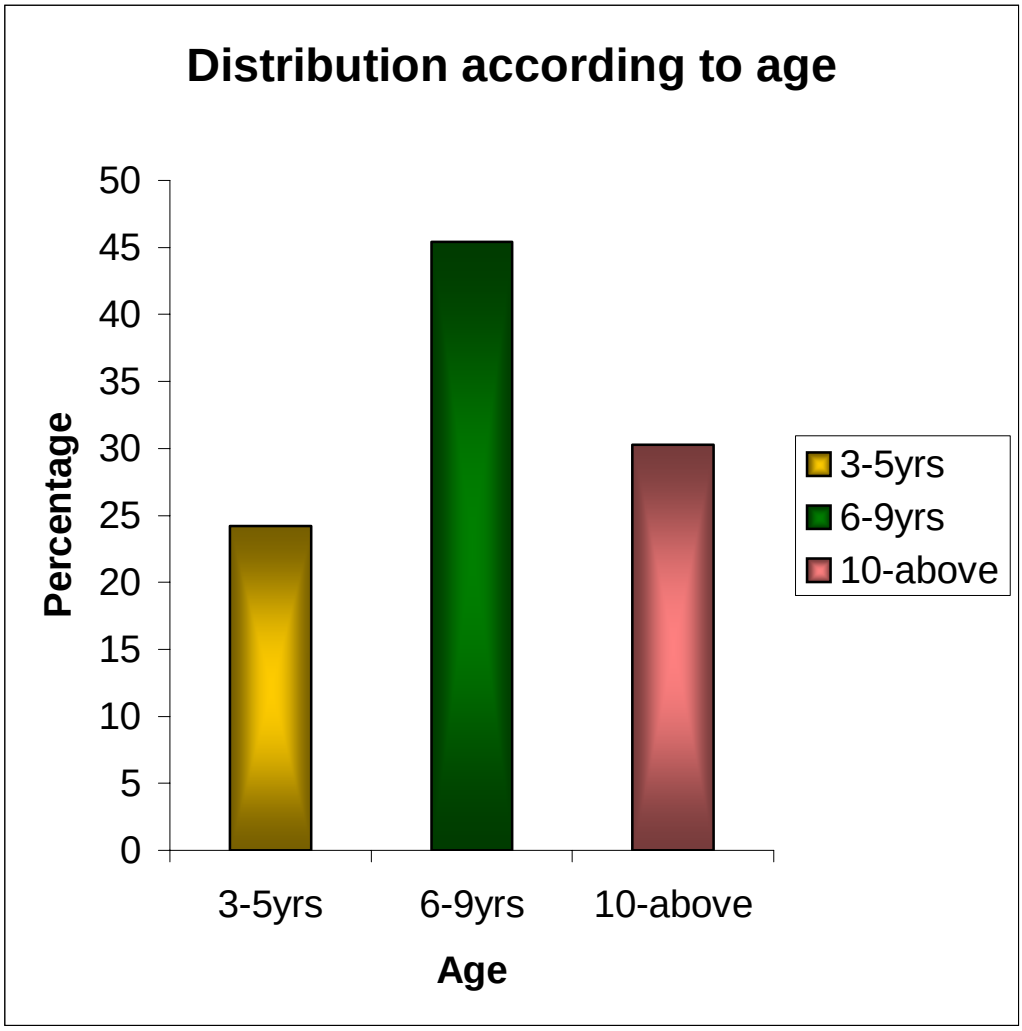
Figures in brackets are percentages, §: Excellent vs good+ fair

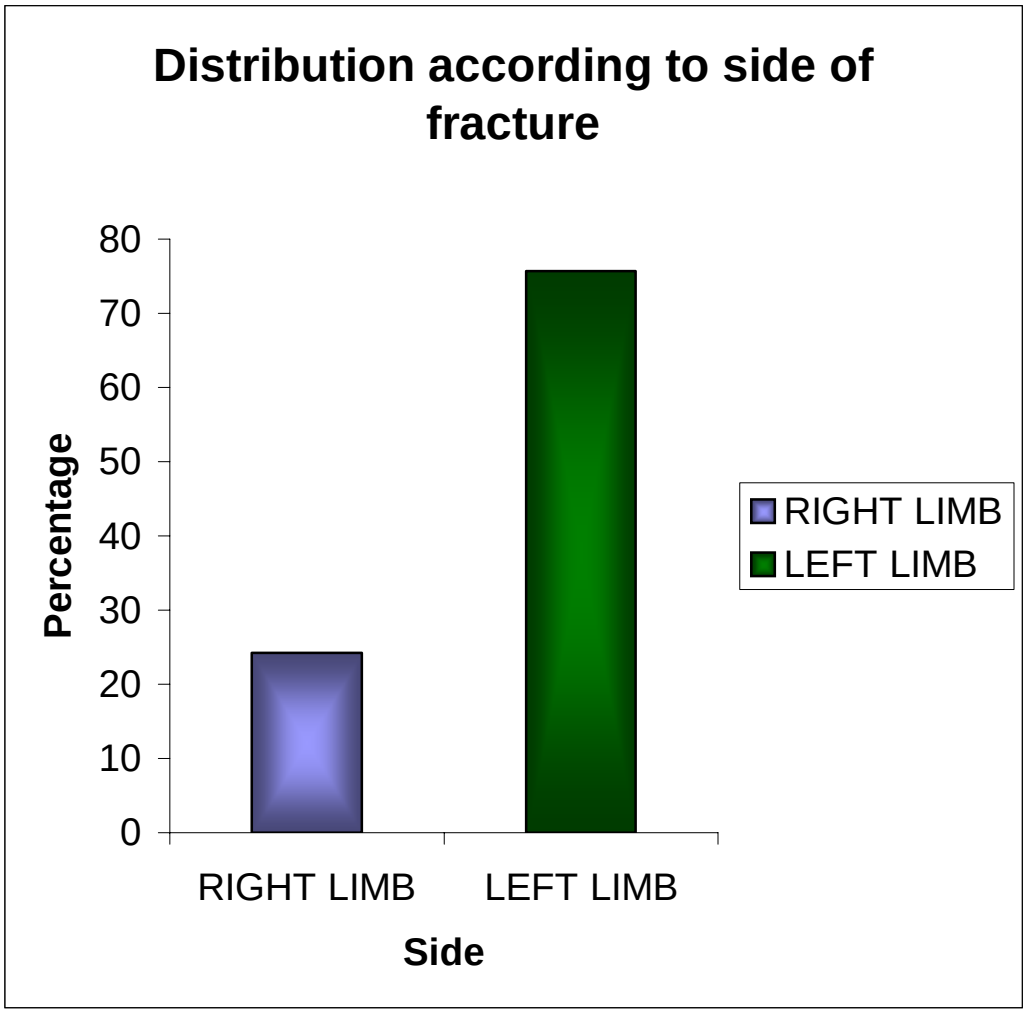
In this study the age of the patient shown statistically significant (P=0.010) difference in terms of the outcome based on Flynn criteria. The mean age of the 30 subjects who had excellent Flynn criteria is 7.2 ± 2.77, which was lower than the Good and fair Flynn criteria subjects.

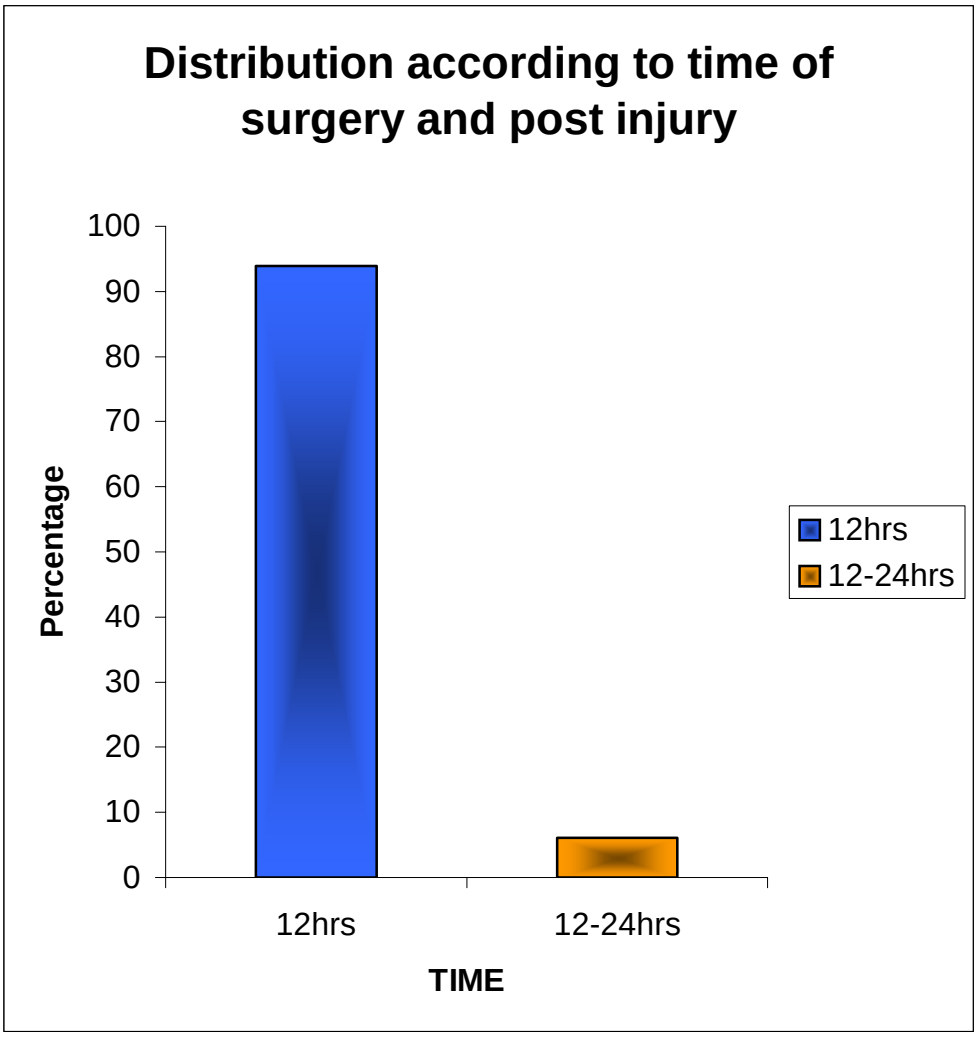
Table VI : Association of side of the fractured limb with gender, complication, K wire removal time, ROM loss and FLYNN criteria.

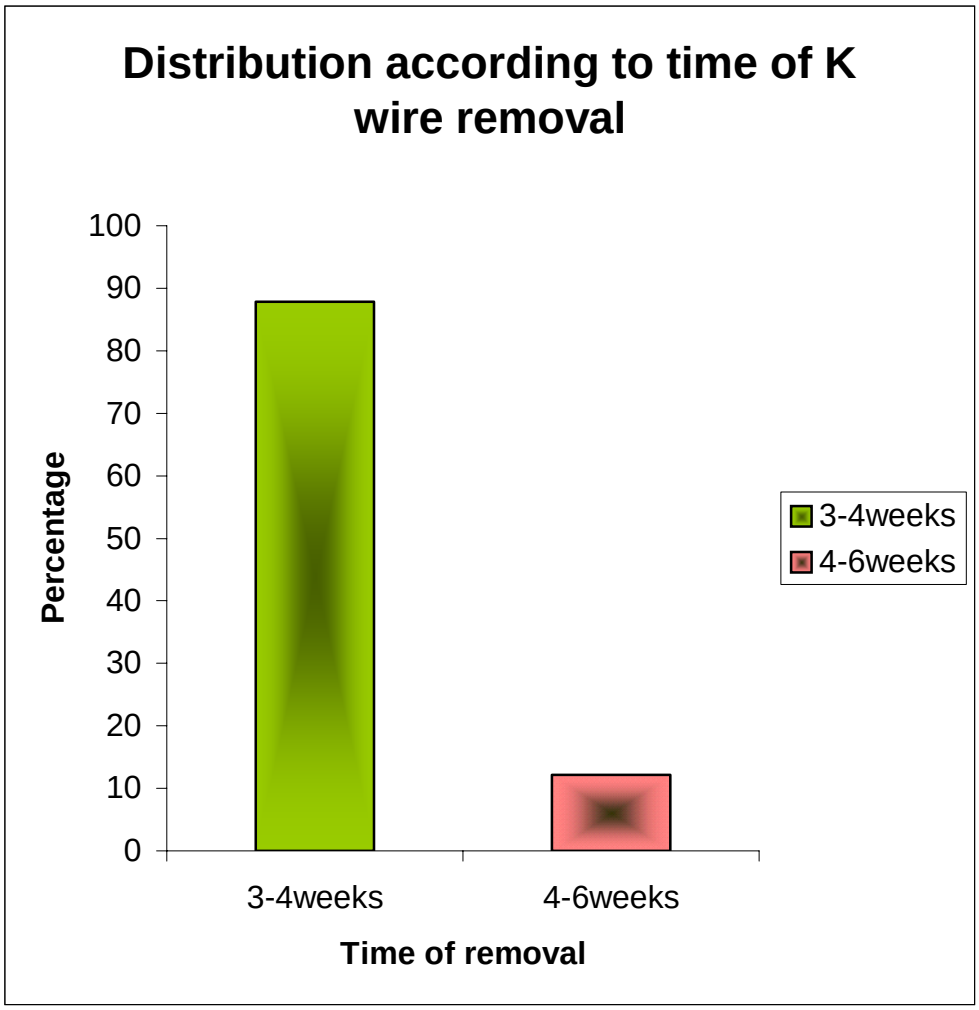
	Left side (n=25)	Right side (n=8)	χ^2 value	P value
Sex				
Males	19(85.7)	7(14.3)	--	0.652
Females	6(73.1)	1(26.9)		
Complication			1.886	0.390
Nil	20(71.4)	8(28.6)		
Pin tract infection	2(100)	-		
Wound infection	3(100)	-		
K wire removal time	3(50)	3(50)	2.757	0.252
3 Weeks	22(81.5)	5(18.5)		
4 Weeks	3(75)	1(25)		
5 Weeks				
ROM loss				
< 5	22(73.3)	8(26.7)	--	0.560
> 5	3(100)	-		
FLYNN Criteria				
Excellent	22(73.3)	8(26.7)	1.056	0.590
Good	2(100)			
Fair	1(100)			

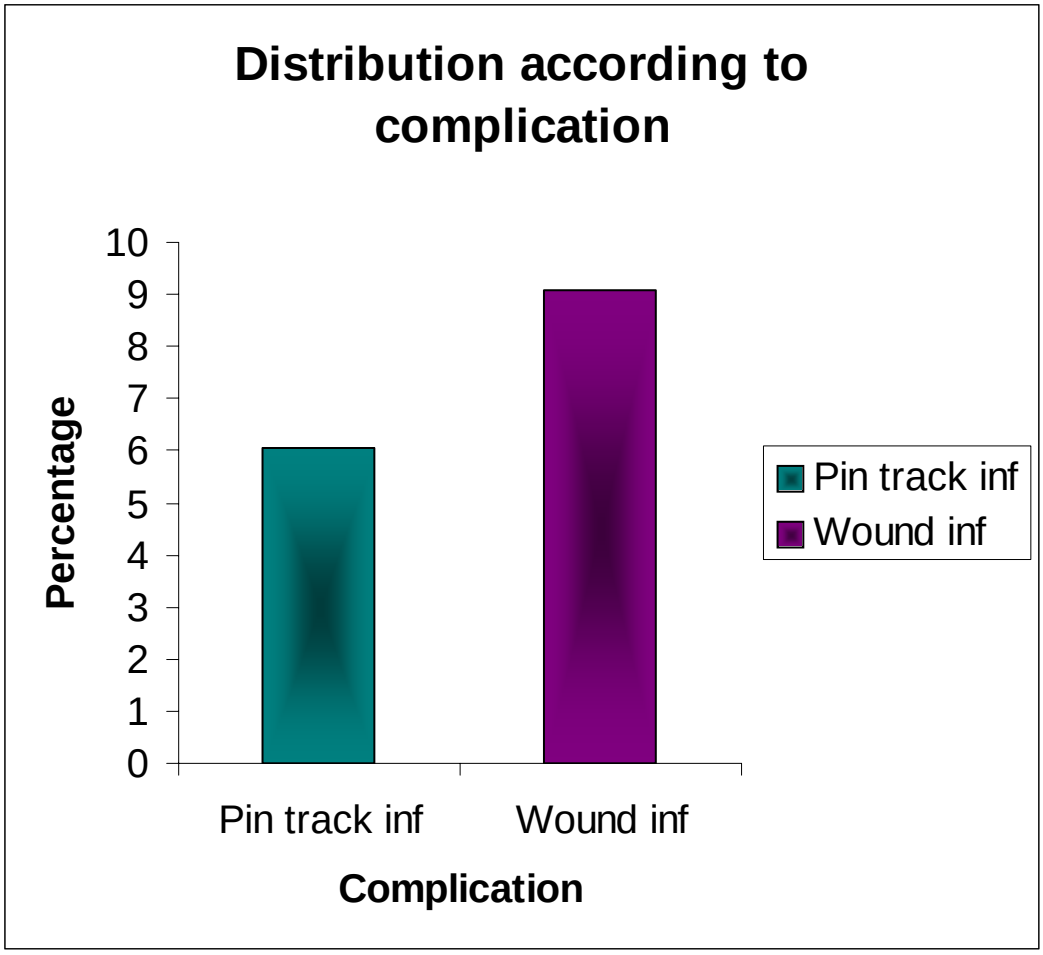

Distribution according to sex
90
80
70
60
50
40
30
20
10
0
Percentage
male
female
Gender
male
female

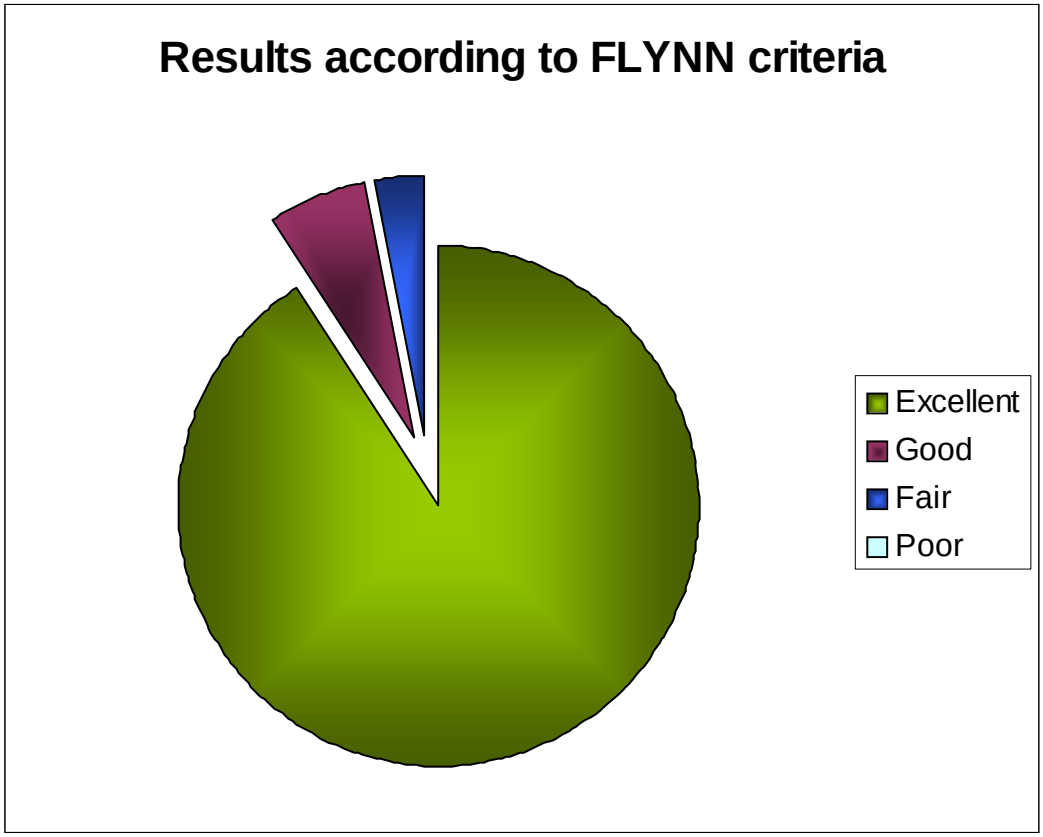

Distribution according to age
Percentage
50
45
40
35
30
25
20
15
10
5
0
3-5yrs
6-9yrs
10-above
Age
3-5yrs
6-9yrs
10-above


Distribution according to side of fracture
80
70
60
50
40
30
20
10
0
Percentage
RIGHT LIMB
LEFT LIMB
RIGHT LIMB
LEFT LIMB
Side


Distribution according to time of surgery and post injury
100
90
80
70
60
50
40
30
20
10
0
Percentage
12hrs
12-24hrs
TIME
12hrs
12-24hrs


Distribution according to time of K wire removal
100
90
80
70
60
50
40
30
20
10
0
Percentage
3-4weeks
4-6weeks
3-4weeks
4-6weeks
Time of removal

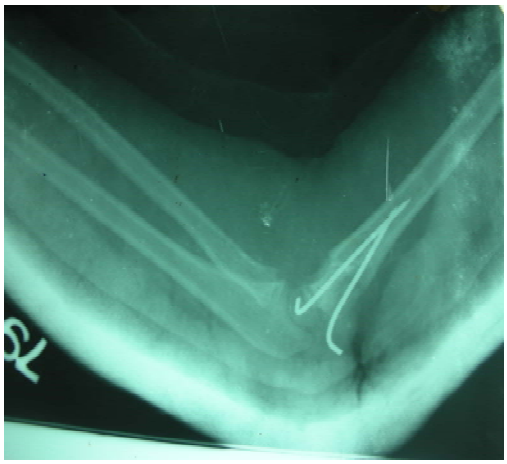

Distribution according to complication
Percentage
10
9
8
7
6
5
4
3
2
1
0
Pin track inf
Wound inf
Complication
Pin track inf
Wound inf


Results according to FLYNN criteria
Excellent
Good
Fair
Poor

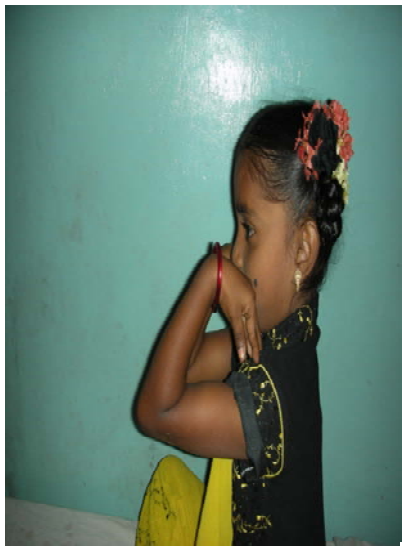
All the 33 patients were followed up with mean follow-up period of 8.39±3.14 months. The minimum follow-up was 4 months and maximum was 16 months. The follow-up duration was comparable across gender, age groups, complication, Range of motion loss and Flynn-criteria outcome. The difference between groups were not statistically significant ($P>0.05$).

Preoperative

Post operative



Follow up



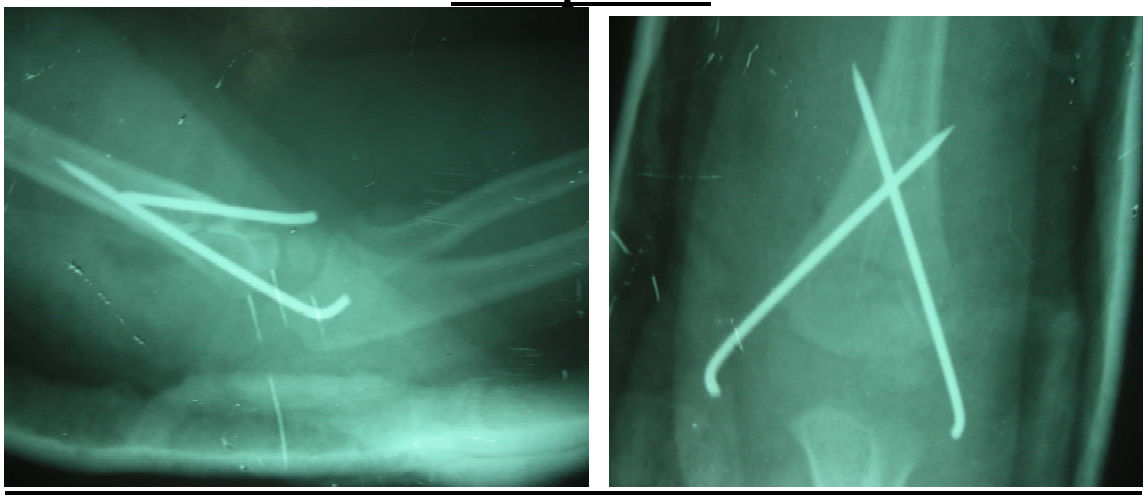
Scar

Preoperative **Post operative**

Follow up

Preoperative

Post operative



Follow up

Complications

Wound Healed by Secondary Intension

Loss of ROM

Complications
Wound infection healed by secondary intension

Loss of ROM

DISCUSSION

Supracondylar fractures of humerus in children are still difficult to handle because of the age group involved and difficulty in maintaining near anatomic reduction by closed means. Dameron[29] and Green[5] explained, holding a reduction with rotational deformity of supracondylar humerus was like balancing two knives on one another .

In our study of thirty three patients with Gartland type III supracondylar fracture of humerus, the mean age is seven years[30]. Boys have had a higher incidence than the girls with a ratio of 3:2.

Non-dominant side or left side is involved more than the dominant or right side[30] .

In our study we advocated open reduction and crossed K-wire fixation for the primary treatment of type III fractures.

Wilkins K E and Rosemont I L[31] in their study cite the advantages of hematoma evacuation, reduction in edema and

accurate fracture reduction in open reduction and internal fixation.

Basom WC et al[17], Shifrin p et al[18] and Wieland A et al[19] in their studies showed excellent results with the use of open reduction.

Two relatively recent reports by Archibald D A et al[20] and Cramer K et al[21] showed excellent results in most patients with the use of open reduction.

In a comparison study between closed reduction with percutaneous pinning and open reduction with pinning by Kaewpornsawan K et al[32], the author concludes that both treatments gave good results.

In most of the studies of closed reduction and pinning[33,34], they cite the risk of development of cubitus varus. But in open reduction, anatomic reduction is achieved which eliminates this

complication. In our study even though it is very early to observe, we had no cases of cubitus varus deformity.

In our study we used Campbell's approach for fixation. We had three cases of range of movement loss >5 degree out of thirty three patients mainly due to wound infection in post-operative period.

Sibly T et al[25] in their study cited that there was no increase in loss of movement in open reduction when compared with closed reduction and percutaneous pinning.

Kasser J et al[24] also found no loss of motion in elbows operated using triceps splitting approach.

Gruber and Healey[23] also recommended the posterior approach to elbow for open reduction.

In our study we used crossed K- wires for internal fixation.

Zionts L E et al[2] in their study compared the torsional strength of pin configuration between crossed pinning and lateral

entry pinning , found out that crossed pinning is more stable than lateral entry pinning.

In our study we had two cases of pin tract infection and three cases of post operative wound infection. Which were settled after appropriate care. Three cases of wound infection result in loss of range of motion of > 5 degree mainly due to poor post operative mobilisation of elbow by the patient.

In a study conducted by Muhall K J et al[36] in 2000 on 16 children with supracondylar fractures, had 13 patients in excellent group ,2 patients in good category and one in fair group according to Flynn's criteria. He suggested open reduction and internal fixation is an effective and safe method of primary treatment and is also associated with good outcomes.

Srivastava S[37] in his study conducted during 2000 , which consists of 42 children of type III supracondylar fractures using posterior triceps splitting approach with crossed K – wires,

showed excellent results in 81% , good in 17% and pin tract infection in 14% of cases.

For closed reduction and percutaneous pinning C- arm and power drill is mandatory[#]. Closed reduction and maintaining the reduction during pinning needs experience[15].

In our hospital where the emergency theatre at present does not have a C-arm, open reduction and internal fixation using crossed K- wires are being carried out routinely.

Limitations of this study:

1. It is not a comparative study
2. Shorter period of follow up

CONCLUSION

In conclusion of our study about the management of Gartland type III supracondylar fracture of humerus in children by open reduction and internal fixation using crossed K – wires, we propound that this method of management is ideal for our set up for the following reasons

1. Immediate anatomic reduction of fracture was carried out there by eliminating the complications like Volkmann's ischemic contracture and cubitus varus deformity.
2. Soft tissue damage was less as compared to the repeated manipulation during closed reduction there by reducing the risk of myositis ossificans.
3. Technically not very difficult to execute when compared to the closed reduction and percutaneous pinning. This is reproducible.

4. Crossed K – wires provides stability for early mobilization of the elbow and there by avoiding the soft tissue contracture.
5. The anxiety of the parents on seeing their child with gross deformity and child's agony of pain were pacified by taking up for surgery at the earliest and providing moral support to them.
6. Early management of the fracture reduces the period of absenteeism in school for the child.

Results of our study is comparable with the earlier studies, which advocate open reduction internal fixation using crossed K – wires is the ideal treatment for Gartland type III supracondylar fractures of humerus in children .

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APPENDIX I

Flynn's Criteria[28]

Results	Cosmetic factor- loss of carrying angle(degree)	Functional factor-loss of motion (degree)
Excellent	0-5	0-5
Good	6-10	6-10
Fair	11-15	11-15
Poor	>15	>15

APPENDIX II

Consent Proforma

Title : Management of Gartland type III supracondylar fracture of humerus in children by open reduction and internal fixation using crossed K-wires

Aim : . The aim of this study is to evaluate the outcome of management of Gartland type III supracondylar fracture of humerus in children by open reduction and internal fixation using crossed K – wires

Consent : I have been explained about the nature of my child's injury, methods of treatment, potential complications and need of regular follow up visits in my own vernacular language.

I hereby give my consent for including my child in this study.

Signature

APPENDIX III

CLINICAL PROFORMA

1. Name

2. Age

3. Sex

4. In-Patient no.

5. Mode of injury

6. Side of injury

7. Dominant side

8. Gartland Type

9. Associated injury

10. Associated complications

11.Time and Date of injury

12. Time and Date of surgery

13. Post operative complication

14. Date of elbow mobilization

15. Date of suture removal

16. Date of K-wire removal

17. First follow up after K-removal:

Date	ROM	CA

18. Further follow ups:

Date	ROM	CA

19. Late complications

20. Date of last follow up

21. Flynn Criteria score

22. Outcome of the procedure

APPENDIX IV

MASTER CHART

Sl.no	Name	Age	Sex	Side	Timing of surgery (post injury)	Procedure	Complication	Time of K Wire removal (in weeks)	ROM LOSS	Loss of carrying angle	FLYNN CRITERIA	Follow Up(months)
1	Gana	10	F	L	12	ORIF		4	0	0	E	16
2	Arav	7	M	L	12	ORIF		4	0	0	E	15
3	Pras	8	M	L	12	ORIF		4	0	0	E	12
4	Vinn	7	M	L	12	ORIF		4	0	0	E	12
5	Kala	7	M	L	12	ORIF		4	0	0	E	12
6	Nisa	6	M	L	12	ORIF	Pin tract inf	4	0	0	E	12
7	Raj	10	M	R	12	ORIF		4	0	0	E	11
8	Suba	3	M	R	12	ORIF		3	0	0	E	11
9	Gaya	5	F	L	12	ORIF		4	0	0	E	11
10	Vetr	7	M	L	12	ORIF		4	0	0	E	10
11	Kart	11	F	L	12	ORIF	Wound inf	4	15	0	F	10
12	Ajit	7	M	L	12	ORIF		4	0	0	E	10
13	Akas	3	M	L	12	ORIF		3	0	0	E	9
14	Vetr	11	F	L	12	ORIF	Wound inf	4	10	0	G	9
15	Prag	11	M	L	12	ORIF		4	0	0	E	9
16	Anan	6	M	L	12	ORIF		4	0	0	E	8
17	Mani	4	F	L	12	ORIF		3	0	0	E	8
18	Man	11	M	L	24	ORIF		5	0	0	E	8
19	Siva	8	M	L	12	ORIF		4	0	0	E	8
20	Kann	9	M	R	12	ORIF		4	0	0	E	6
21	Siva	4	F	R	12	ORIF		3	0	0	E	6
22	Prak	13	M	L	12	ORIF	Wound inf	5	10	0	G	6
23	Sidd	3	M	R	12	ORIF		3	0	0	E	6
24	Vima	7	M	R	12	ORIF		4	0	0	E	6
25	Shar	6	M	L	12	ORIF		4	0	0	E	6
26	Kris	12	M	L	12	ORIF	Pin tract inf	5	0	0	E	6
27	Abi	12	M	L	12	ORIF		4	0	0	E	6
28	Vija	5	M	L	12	ORIF		4	0	0	E	6
29	Vija	7	M	R	12	ORIF		4	5	0	E	5
30	Venk	13	M	R	24	ORIF		5	5	0	E	5
31	Nand	7	F	L	12	ORIF		4	0	0	E	4
32	Vemu	5	M	L	12	ORIF		3	0	0	E	4
33	Kath	6	M	L	12	ORIF		4	0	0	E	4

KEY TO MASTER CHART

SEX: M- MALE

S- SEX

SIDE OF INJURY: R- RIGHT

L- LEFT

ORIF: OPEN REDUCTION

AND INTERNAL FIXATION

inf: INFECTION

ROM: RANGE OF MOTION

FLYNN CRITERIA:

E- EXCELLENT

G- GOOD

F- FAIR